



**Center for
Clean Air Policy**

Methane Mitigation from Dairy Digesters in California: Reduction Potential, Barriers and Regulatory Options

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California Manure Methane Overview

- Methane (CH_4) emissions from manure management totaled 5.2 MMTCO₂e in 1999 (*Inventory of California Greenhouse Gas Emissions and Sinks: 1990-1999*)
- Manure management represents one of the fastest-growing sources of GHG emissions in California [annual average growth rate = 5.2% from 1990 (3.29 MMTCO₂e) to 1999]
- Bio-digesters can recover manure CH_4 for direct use or electricity generation, reducing GHG emissions and improving air and water quality

Digester Programs in California (1)

Three state programs in California support digester electric power projects:

- The Dairy Power Production Program (DPPP) was established in 2001 under SB 5X
 - Project developers can choose between buy down grants covering up to 50% of the total capital costs of the system, or incentive payments based on a cost of 5.7 cents per kWh.
 - About 60 out of 2,300 farms applied. 14 projects (~3.5 MW capacity) were approved for grants totaling \$5.8 million. The program is now closed to new applications.

Digester Programs in California (2)

- Self-Generation Incentive Program (SGIP)
 - The SGIP offers financial incentives (in the form of payments for a portion of capital costs) to customers who install certain types of distributed generation facilities.
 - Maximum generator system size allowed is 5 MW, with the total incentive payment limited to 1 MW.
 - As of January 2005, there were 11 dairy farm digester projects in the program totaling ~2.3 MW. For dairy farms incentive payments have ranged from \$1 to \$9 per watt.
 - The SGIP has been extended through 2007.

Digester Programs in California (3)

- A pilot program for net metering for digester projects was established under Assembly Bill 2228 in 2002
 - Law requires the state's three largest investor-owned utilities (PG&E, SCE, and SDG&E) to offer net metering to new dairy farms that install digesters with a capacity of 1 MW or less.
 - Each utility is required to offer net metering only up to a total of 5 MW, for an aggregate total of up to 15 MW.
 - Assembly Bill 728 would extend the existing program indefinitely; remove the 5 MW and 15 MW limits; and increase the capacity limit of eligible digesters to 10 MW. The bill's prospects are unclear.

ICF Analysis*: Baseline

- ICF Consulting has prepared CH₄ emission reduction and cost estimates for various manure digester electric power options for the California Energy Commission (*Emission Reduction Opportunities for Non-CO₂ Gases in California*, March 2005*)
- ICF developed a CH₄ emissions baseline under business-as-usual conditions, using projected animal populations (includes dairy cattle, beef cattle, poultry and swine) and distribution of manure management systems:

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Methane Emissions from Manure Management Systems (MMTCO ₂ e)				
2000	2005	2010	2015	2020
5.87	6.38	6.64	6.90	7.16

Original ICF estimates have been reduced by 25% to account for N₂O emissions



* This analysis was supported by the CEC PIER Program.

Dairy Farm Mitigation Options

- ICF considered eight options for CH₄ mitigation at dairy farms, all based on capturing methane to generate electricity:
 - » Cover existing lagoon at small (250-cow) dairy, 30 kW electrical capacity
 - » Install lagoon and cover at small (250-cow) dairy, 30 kW
 - » Install complete-mix digester at medium (1,000-cow) dairy, 100 kW
 - » Install plug-flow digester at medium (1,900-cow) dairy, 160 kW
 - » Cover existing lagoon at large (5,000-cow) dairy, 600 kW
 - » Install lagoon and cover at large (5,000-cow) dairy, 600 kW
 - » Install two-stage plug-flow digester at large (7,200-cow) dairy, 1,000 kW
 - » Install centralized digester located among multiple large farms, at least 1,000 kW

Key Assumptions in ICF Draft Analysis

- For each option, achievable CH₄ reductions are estimated based on the associated maximum technical potential and reduction efficiency
- The total number of dairy cows is assumed to increase by 3% in the 2004-2010 period, and 2% from 2010 to 2020
- Farmers receive a credit of 8 cents per kWh of electricity generated, up to the farm's total annual electricity demand (no credit is given for excess power sent to the local grid)*
- Federal production tax credit for renewable power generation is not available
- GHG savings include methane reductions from manure management only
- Costs include capital cost of lagoon and cover, gas handling equipment, and generating unit; interconnection and required permits; operation and maintenance
- Cash flows in future years are discounted at 4% annually, at a zero % tax rate



*CCAP estimates, however, that under the current net metering law, development of the full 15 MW required under AB2228 would result in ~0.4 MMTCO₂e reduced. It therefore appears that ICF assumes excess power is given freely back to the grid.

ICF Results (1)

- For each manure management option, ICF estimated the total annual reduction potential and the cost per metric ton CO₂e reduced. The results are shown on slide 11.
- CH₄ emission reductions from all options total 5.82 MMTCO₂e in 2010, at a total cost of \$21.7 million. Reductions in 2020 total 6.24 MMTCO₂e at a total cost of \$23.4 million.
- The average net cost per metric ton reduced is just over \$3.7 in both years

ICF Results (2)

- Nearly one-half of the total reductions (2.78 MMTCO₂e in 2010, 2.99 MMTCO₂e in 2020) could be achieved by implementing only the three measures that provide a net cost savings
- The net savings per metric ton reduced from all three measures combined would be \$3.1 in both years
- Most of the remaining reductions can be achieved for less than \$10 per ton CO₂e.

ICF Options: Reductions and Costs

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Option	Cost per MTCO ₂ e	2010		2020	
		Reductions (MMTCO ₂ e)	Cost (million \$)	Reductions (MMTCO ₂ e)	Cost (million \$)
Covered existing lagoon, large dairy	\$ (3.94)	1.73	\$ (6.82)	1.86	\$ (7.33)
Installed and covered lagoon, large dairy	\$ (2.21)	0.74	\$ (1.64)	0.80	\$ (1.77)
Plug flow, medium dairy	\$ (0.61)	0.31	\$ (0.19)	0.33	\$ (0.20)
Two-stage plug flow, large dairy	\$ 2.73	0.09	\$ 0.25	0.09	\$ 0.25
Complete mix, medium dairy	\$ 6.00	0.13	\$ 0.78	0.14	\$ 0.84
Covered existing lagoon, small dairy	\$ 8.81	1.73	\$ 15.24	1.86	\$ 16.39
Centralized digester	\$ 9.54	0.33	\$ 3.15	0.36	\$ 3.43
Installed and covered lagoon, small dairy	\$ 14.78	0.74	\$ 10.94	0.80	\$ 11.82
Totals		5.82	\$ 21.71	6.24	\$ 23.43

All costs in year 2000 dollars. Totals may not sum due to rounding.

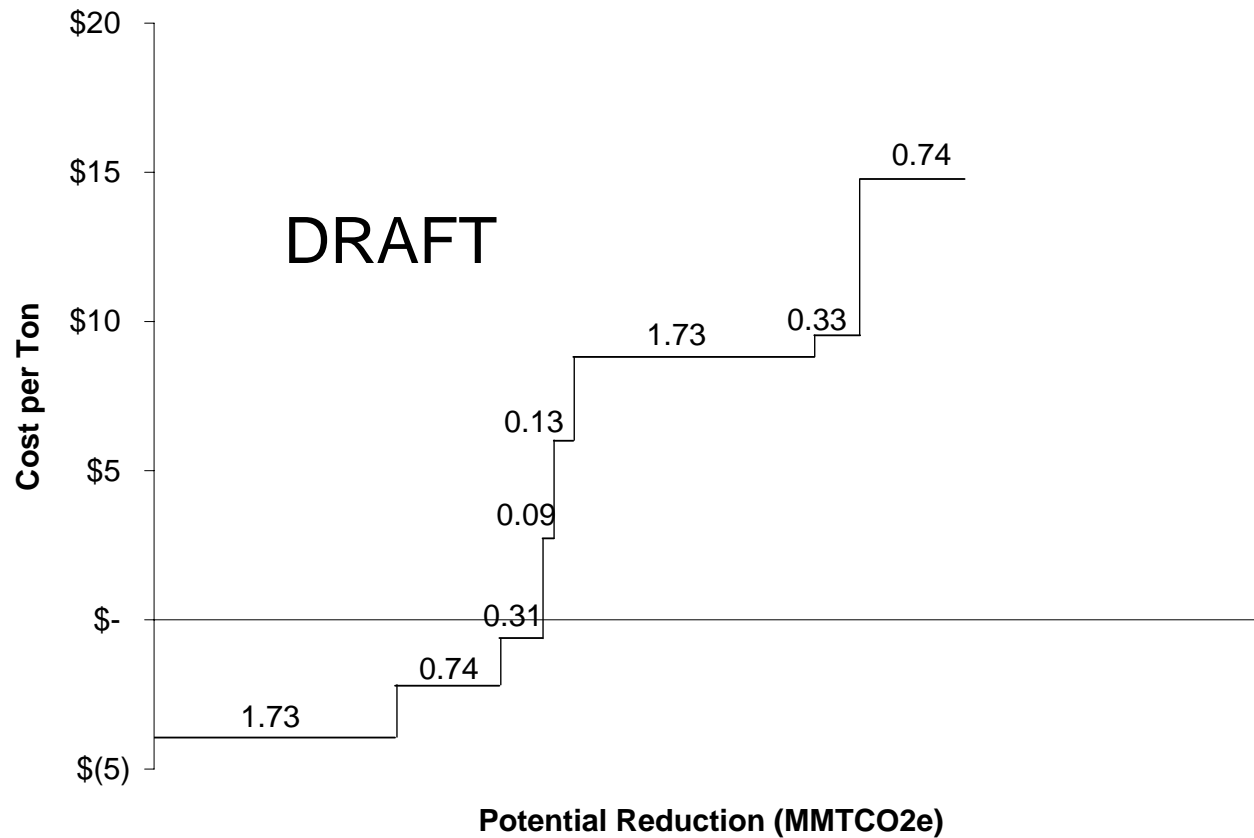
Reductions Below Baseline

- Implementation of all measures costing less than \$0 per metric ton would reduce CH₄ emissions to a level over 40% below the baseline in both 2010 and 2020
- Implementation of measures costing less than \$10 per metric ton would reduce emissions by 75% below baseline levels in those years

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Methane Baseline and Total Reductions (MMTCO ₂ e)		
Reduction	2010	2020
Baseline	6.64	7.16
Less than \$0 per metric ton	2.78	2.99
<i>% below baseline</i>	42%	42%
Less than \$10 per metric ton	5.06	5.44
<i>% below baseline</i>	76%	76%

ICF Methane Cost Function for 2010



Project Development Barrier: Utility Actions

- In recent years IOUs have found it difficult to remain profitable. As a result, there has been opposition to distributed generation projects (such as digesters) and net metering.
- Municipal utilities have been more willing to consider working with digester projects and allowing net metering
- Utility opposition combined with opposition from some environmental groups make significant new digester development unlikely without new legislation or regulation
- Advocates for digester project development have therefore recommended making the current pilot program permanent (potentially through passage of AB 728)

Project Development Barrier: Interconnection Procedures

- In California, distributed generators must have an interconnection agreement with a utility or other provider to be connected to the grid
- Rule 21 requires a detailed application and interconnection study, paid for by the project developer. Those wishing to contest the costs or findings of the study face a complicated appeals procedure.
- The interconnection process can be time-consuming and prohibitively expensive for dairy farms. Utilities may also require installation of additional equipment, adding to the total cost.
- Wind and solar unit projects face a less expensive, more direct interconnection procedure.
- Extending the treatment of wind and solar projects to digesters and simplifying and streamlining the appeals process could facilitate the interconnection and development of digesters.

Project Development Barrier: NO_x Emissions

- NO_x emissions from digesters pose a barrier to project development in ozone non-attainment areas.
- The San Joaquin Valley Air Pollution Control District is considering a rule that would require dairies to meet a 50 ppm NO_x emission standard for waste gas engines by 2007, a significant reduction from the uncontrolled emission level of 200-300 ppm.
- NO_x emissions from digester generators can be reduced through use of lean-burn engines or installation of select catalytic reduction (SCR) technology.
- American lean-burn engine models are not currently available below 350 kW, so this would be an option for large dairies only. The use of SCR with digesters is largely untested and requires prior cleanup of the waste gas, which increases the complexity and required maintenance of the engine.
- The cost of NO_x control could be prohibitively expensive for many digester projects should such reductions be required. CCAP will work with CEC and ICF to assess the cost impacts of adding SCR to different sized units under different net metering assumptions.

Measures to Encourage Project Development

- Renewable energy certificates (RECs)
 - Dairy digester power projects are included as eligible forms of renewable energy under the California RPS
 - Expanding the definition of RECs to include both generation-related benefits (reduced emissions of pollutants and GHGs) and the additional benefits from moving manure from open to closed areas could provide a cost incentive to development of digester projects
- Turnkey systems
 - With the primary focus of dairy farms on milk production, farmers may be unfamiliar with digester generation technologies.
 - Uncertainty over net metering and the potential costs and benefits from digesters may also make them less willing to invest the effort and bear the risks from such investments.
 - Development of digester systems that can be installed without significant customization may facilitate independent third-party operation of digester systems and thus encourage digester deployment

Avoiding Potential Problems with Gaming

- It will be important to begin with a mandatory reporting program or mandatory participation in a registry to understand which digesters currently use lagoons and which apply their waste to farmland.
 - » If a dairy that had previously applied its waste to land opts to instead use a digester, this could result in an emissions increase. Additional calculations are needed to determine the degree to which this is an issue.

Dairy Methane Regulation Options: Voluntary Approaches

- A voluntary program (such as US EPA's Ag STAR program) would encourage but not require dairy farms to install digester power systems by providing information and training to dairy farms seeking to install digesters.
- This approach would be the most feasible from a political standpoint, and would likely meet minimal opposition from dairy farmers
- A voluntary approach appears unlikely to achieve significant methane emissions reductions in the absence of net metering. Specifically, guaranteed net metering is needed to ensure the long-term recovery of project development costs.

Incentive Programs

- An incentive-based program similar to the DPPP and SGIP would provide financial assistance to qualified digester projects
- Program could provide a share of the total project or individual component capital cost, or a production tax credit based on total generation, lowering the cost of digester projects and encouraging new development.
- Incentives might be used to reduce the added costs of adding SCR or other technology to reduce NO_x emissions.
- Even with incentive payments, however, the record of the DPPP suggests that the overall participation level would likely be relatively small
- Achieving higher levels of reductions may require a more aggressive program with higher funding levels and/or the removal of existing barriers to penetration.

Technology Requirements and Emissions Benchmarking (1)

- Technology Approach
 - Would require the installation of specific digester technologies on dairy farms
 - Ideally, the characteristics of dairy farms in certain categories (size, type of manure handling systems used, interconnection potential, etc) would be matched with the most appropriate technology
- Benchmarking
 - Would require farms to meet a specific CO₂ equivalent emission rate per animal or unit of economic output, referenced to various technology options and/or best practices at similar farms
 - Provides more compliance flexibility than technology-based approaches in terms of how the standard is set and the potential set of compliance options
 - The program could be designed to allow trading within the sector, and there could be links with a trading system

Technology Requirements and Emissions Benchmarking (2)

- Both programs would ensure broad participation and achieve significant emission reductions
- Either approach would risk increases in total emissions if dairy farm output increases over time
- The cost of both programs would be high relative to an approach that allows trading.
- The actual cost depends on the stringency of the requirement. Net metering would allow application of stronger requirements.
- Costs to farms could be reduced by allowing methane flaring in lieu of electricity generation in some cases.

Emissions Cap and Trade

- Would set an overall cap on total methane emissions from farms. Cap level could be chosen at more or less aggressive levels, considering desired reductions and costs for this sector.
 - Could set cap at a level that allows over compliance and recovery of costs.
- The cap would ensure achievement of a given emissions level even if emissions were to increase due to growth in farm output.
- The industry could potentially use a variety of compliance options to meet the cap, including installation of digesters, flaring, installation of covered lagoons or purchase of allowances or offsets.
 - This flexibility would likely lower the costs below those in a technology or benchmarking approach.
- Emissions trading would also allow for the possibility of linking dairy regulation with other sectors (e.g., electric power, industry)

Conclusions

- Various cost-effective options are available to the dairy sector, including measures costing less than \$0 and less than \$10 per ton CO₂ under existing net metering assumptions where excess power cannot be sold back to the grid.
- A more favorable net metering policy would further improve the economics whereas stringent NO_x requirements could hamper the economics of biodigesters. More study is needed to determine whether a strong net metering policy will outweigh the added costs of installing SCR technology to reduce NO_x emissions.
- Improved interconnection rules are also needed to overcome barriers to digester deployment.
- Mandatory reporting will help prevent emissions increases associated with wetting manure that is already dry.
- A variety of voluntary or mandatory policy approaches could be used to encourage CO₂ reductions from manure digesters, depending on the group's later assessment of whether reductions from this sector are needed to meet a statewide reduction goal.

Next Steps

- Additional cost analysis is needed to understand the impacts of a more favorable net metering scenario.
- Additional cost analysis is needed to understand the costs of NO_x control under the baseline and alternative net metering scenarios.

Questions for Discussion

- Is a more favorable net metering policy a viable option in California?
- Which voluntary and mandatory implementation options should be examined in detail for further discussion?